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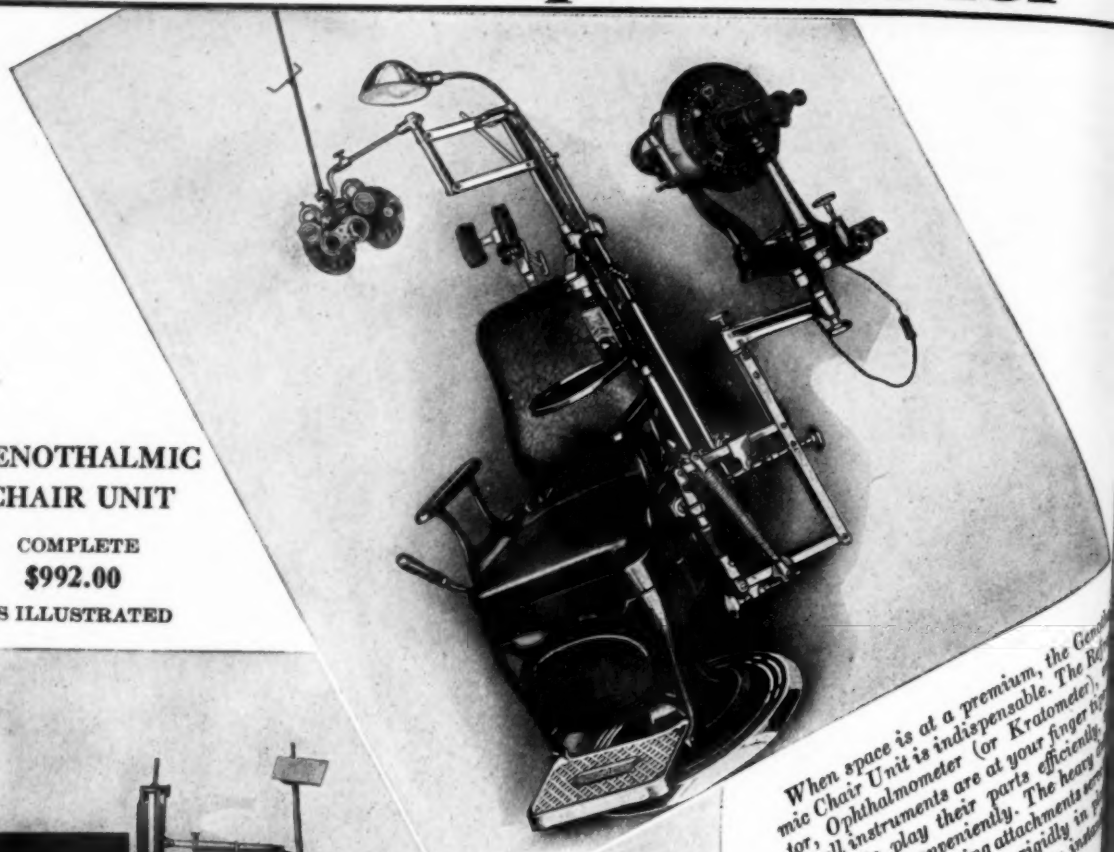

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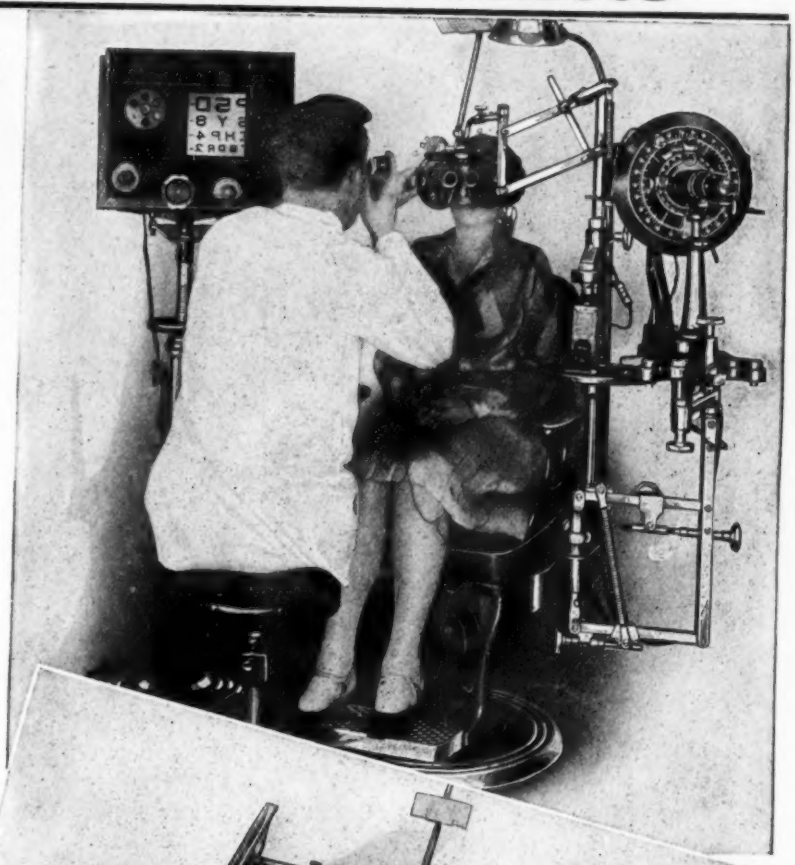

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VOL. 5 NO. 8

AMERICAN JOURNAL OF OPTOMETRY

FUSION TRAINING[1]

J. Neumueller, Opt.D.
Philadelphia, Pa.

There is hardly a subject which has found more consideration within the last three to five years than Muscle and Fusion Training. It seems as if for some time the optometric world forgot entirely the controversies over accommodation and its paralysis by drugs, and realized the presence of the six pairs of extra ocular muscles. Aware of this negligence, we seem now to be bent to make up for it. In spite of all these recent developments and newly constructed instruments we must remember that a group of leading men have done muscle work twenty and more years ago.

This paper is based upon a procedure which has been expounded by Wells,[2] and which has been proved by time and experience to be successful, provided the patient and the refractionist are exhibiting the necessary amount of patience that is so essential in muscle work.

The human eye is not a static optical instrument, but a dynamic physiologic one, subject to all kinds of changes of physiological and psychological origin.

Essentials for Comfortable Vision

The two main requisites for visual efficiency are:

1. Clear macular perception.
2. Single binocular vision.

The clear macular perception may partly or wholly be accomplished by the accommodative apparatus as in hypermetropia, or by means of correcting lenses.

The single binocular vision which is a more recent acquisition of the species, however, is a rather intricate psychic faculty, depending on physical, physiological and psychological conditions.

The purely physical condition is that any object in order to be

recognized as single shall create an image on the left retina and one on the right retina on corresponding points. Each eye has a monocular field of vision which is limited by the anatomical interference of nose and orbit, farther extended towards the temporal side than towards the nasal side. The overlapping portion of these two monocular fields of vision may be termed the field of single binocular vision. As conjugate retinal points can be defined, the nerve fibers of such points terminate in closely adjoined neurons of the right or left occipital cortex.

This condition is greatly helped by the anatomical structure of the course of the retinal nerve fibers. The temporal left and the nasal right fibers meet in the left occipital lobe and the right temporal and left nasal retinal fibers meet in the right occipital lobe, after semi-decussation of the fibers has taken place in the chiasm or optic-commissure.

The second condition demands the perfect co-operation of the twelve extrinsic muscles in order to direct each eye so that the respective left and right eye image of an object point shall fall on corresponding points of the two retinae. We shall later on consider more closely this condition and the nerve supply for this muscular activity.

The third condtion is of a rather psychological nature. As we use our eyes in every-day life, we look at a world of three dimensions. There is depth to it and the points of various distances can not fall on corresponding points of our retinae and still we experience no diplopia, no matter whether we fix objects near by, or far away. When I look at the far wall of this room, I should, geometrically speaking, see the chairs in the first row double, but experience has taught me that they are single, and experience working on my visual brain centers teaches them to see them single. When I put a stereoscopic picture in the holder of this instrument, I shall show you that I can turn the rotary prism through quite some amount, say 20 degrees, and though the patient's eyes hardly follow the prism apex, he will still maintain stereoscopic vision. This psychological factor is highly important and well worth training.

The first condition, the anatomical one, can not be changed, and in cases where it is changed, as for instance, in the creation of a false macula as in strabismus, it proves very much a detriment to perfect fusion.

It is in the second condition the coordination of the extrinsic muscles and third, the fusion sense, that we have to apply training.

Investigation

In order to determine what kind of training we have to apply, let us investigate at least diagrammatically the nerve supply for the various extra ocular muscles of the eye.

A very simple experiment will show us immediately two kinds

of nerve supply of widely different nature. If you should demand anybody to look to his right or left side, or change in any way his line of fixation and this person does not want to comply with your wish, there is no power at your command to make him do so. The change of his point of fixation is, therefore, entirely up to his own free will. The rotation of the eyes is, therefore, a volitional act and the nerve centers controlling this rotation are under the control of the conscious mind.

Every person, however, will maintain single binocular vision within certain limits, whether he wants to or not. For instance, holding 2 or 3 prism diopters base-out before a person's right or left eye would, from a geometric optical standpoint create diplopia. Immediately, however, the person will turn his eye, in this case in, so that re restores single binocular vision. This effort, however, is not volitional and as a matter of fact, the person could not maintain diplopia even if he wanted to. This motion of his eye, being involitional, was brought about by his fusion sense.

Savage[3] represents in diagrammatic form, the brain centers controlling the eye movements. The muscles and their controlling nerves are paired together in such a way that, for instance, one cortical brain center controls the left internal and the right external muscles, thus controlling the sweep of the eye towards the right. Another cortical brain center controls the right internal and the left external recti, thus controlling the sweep of the eye towards the left.

If the visual axis of the two eyes in a perfect state of rest are parallel, we have orthophoria, and the tonicity of each muscle is in perfect balance with the tonicity of its antagonist. When this pair of eyes rotates, we still will have a state of balance because one cortical brain center controls the flow of neuricity to one pair of muscles and we can, therefore, assume that each one of these muscles receives an equal amount of neuricity. Under these conditions there would be no appeal made upon the fusion sense in the interest of single binocular vision.

Again referring to Savage, we have besides the cortical brain centers which control any volitional movement of the eyes, the basal brain centers, which act only under the control of the fusion faculty of the mind. Each extrinsic muscle is connected by means of nerve fibrils with one basal brain center. Should, then, the tonicity of one particular muscle be too weak or too strong and thus disturb the balance with resulting diplopia, the basal brain center of this particular muscle will supply the necessary neuricity to retain this perfect muscle balance in the interest of single binocular vision.

The only possibility of changing the tonicity of a muscle is, therefore, to exercise this muscle through neuricity from the basal brain centers under the control of the fusion faculty. This way of reasoning tells us also immediately what steps must be taken in order to reach with our training the basal brain centers only. It demands

that:—Accommodation and all cortical brain centers controlling the volitional motion of the eye must be at rest.

The Vital Factors

In order to train our fusion sense we have to train its helps:

1. Good visual acuity.
2. Simultaneous binocular vision.
3. Range of fusion—(extent of fusion field).
4. The quality of fusion—(fine detail perception and stereoscopic vision).

At this particular place we can only consider amblyopia ex-anopsia, blindness from non-use, and not any pathologic amblyopia of toxic origin. There are two opposite conflicting theories advanced as to the cause of squint. One theory claims that due to lack of fusion, strabismus develops, and in the wake of this strabismus, suppression of the brain picture of one eye follows. This theory advances, therefore, that the cause of all strabismus is the lack of fusion sense.

The other theory claims hyperopia as the causative factor. By inciting accommodation far beyond the normal demand while the demand for convergence remains normal, the accommodative convergent relation is disturbed, and strabismus results, due to fatigue and in its wake we have diplopia, suppression and finally amblyopia.

Experiences of other refractionists and myself have made me more inclined towards the acceptance of the second theory.

Can Strabismus be Cured?

If we should accept the first theory, we surely should see in any case of strabismus an utterly hopeless and incorrigible state of affairs. With utter lack of fusion and the denial that it can ever be taught after the child has passed its sixth year, we can never expect to bring this pair of eyes to a single binocular control under a non-existing fusion sense, even if we should succeed to defeat the monocular amblyopia. As soon as binocular vision is demanded, one eye would uncontrollably slip away from its binocular position with reappearing amblyopia. The only hope would be a muscle operation for cosmetic purposes only. We know, however, that in many early cases of strabismus the eyes will straighten out under the influence of the plus lenses only, though treatments, of course, shorten considerably this time of recovery. We also know that many cases of strabismus will straighten out if the one afflicted is well beyond the childhood age.

True, there are these border line cases which apparently recovered, will after a certain time, say about one year, slip back again into an almost amblyopic state. These cases demand the ever present vigilance of the refractionist and at least a half-yearly check. It is my belief, that many cases of strabismus discharged as incurable,

after a few months of intense treatments, gave up, or were given up, when the reward of success would have come within the next few treatments.

Amblyopia ex-Anopsia

The treatment of amblyopia ex-anopsia is dictated by its own name. Force the eye to see. The procedure with variation as to taste and temperament of the refractionist will be as follows, occlude the good eye, if possible constantly, if this is not practical, then as long as it is tolerated by the patient. Bandage is preferable, though Walton's celluloid discs are very good. Care must be taken that the patient can not use the good eye by looking outside of the rim of his spectacles. Due to vanity, bandage is not always accepted, the main object is that the poor eye be used and that the patient is occupied with his eye and his hands during these hours of training. A small child may take its meals with the aid of the amblyopic eye. A few useful occupations are: playing with blocks, or with dominoes, matching the numbers. This takes away the odious atmosphere of a treatment against a bodily ill and introduces the competitive spirit of a game. As the eye emerges from the amblyopic state, the nature of the exercises should become more and more exacting. Reading of fine print, drawing, reading music with the amblyopic eye, come under this group of exercises.

Treatment of Amblyopia

Together with these exercises must go our training to gain our second point, namely, simultaneous binocular vision. In order to explain what I mean by this term, let us assume that the amblyopia has been reduced to about 20/60 V. A. and naturally the patient can see very nicely with that eye as long as the urge to use this eye is imperative. When he uses both eyes together and he has the choice of either eye we shall experience a constant suspenopsic condition of the amblyopic eye. This suspenopsia is an exceedingly counteracting factor to single binocular vision under the control of the fusion sense and must be combatted. There is an instrument which is very adaptable for this particular purpose. I refer to the Worth-Black amblyoscope.[4] We have two tubes with receptacles for the pictures. The two pictures are complementary as to their results. The child should see for instance, the mouse in the trap, or the bird in the cage. This particular group of pictures does not come under the heading of fusion because the two retinal images are not alike. The main object is to make the patient see both pictures at the same time, without losing the retinal image in the amblyopic eye. In other words, we tease the amblyopic eye to see. In order to facilitate this, we can use an electric illuminating device consisting of two lamp cups with individual control, it allows us to emphasize the amblyopic image by increasing its illumination, or by decreasing the illumination of its mate. For use, the instrument is to be suspended

from a wall bracket or a stand, the patient rests his elbows on a table working the tubes in the lateral plane until the mouse is in the trap, or the bird in the cage. Any vertical imbalance can be taken up with a special adjusting screw. The patient is then asked what he sees, and if he can not see the mouse, we increase illumination on this object until it becomes visible. Mislead the patient in his answers by cutting one illumination off and on, because children invariably catch on to what they are expected to see and give you an answer to please you. The only fault I can find with the Worth-Black amblyoscope is that all testing and exercising depends upon the answer of the patient without any objective check on part of the operator. The Worth-Black amblyoscope does not have the advantage of the Stereo-Phorometer that the patient's eyes can be observed during exercises.

Another group of amblyoscopic pictures demands fusion or super-imposition. For instance, the F and L letters must be fused together to the letter E, after this has been accomplished, the range of fusion can be extended by increasing this angle between the tubes in convergent squint or decreasing this angle in divergent. The quality training of fusion is better accomplished with the amblyoscope and its stereoscopic pictures.

The principle of the Worth-Black amblyoscope and the Stereo-Phorometer is exactly the same. In amblyopic cases we can not apply the Stereo-Phorometer because we have no means of teasing the amblyopic eye to see by increasing the illumination. As soon as the formerly amblyopic eye has acquired a visual acuity of about 20/40 or 20/50 we prefer to swing the case on the Stereo-Phorometer as this instrument allows a better control. What we want to train is the fusion sense, and the innervation of the extra ocular muscles by the fusional, the basal brain centers only. In order to accomplish this aim we must have the accommodation as nearly at rest as possible with optical means.

Fusion Development

The instrument consists of three lens cells and two rotary prisms of 30 degrees, a P. D. adjustment and a spirit level adjustment. The Stereo-Phorometer has the cards on the carrier 4 inches from the eye, and in order to compensate for this distance we insert a pair of + 10.00 D. Sph. lenses in the lens cell. This means that now the patient is looking actually at infinity. The patient either wears his distance correction, or else this distance correction is also inserted in the lens cells. The patient's eyes are now perfectly at rest as far as his accommodation is concerned, but his eyes shall also be perfectly at rest as far as any strain is concerned in overcoming any present phoria. The P. D. adjustment is set for the patient's P. D. and the B1 card inserted. All cards are based on a P. D. distance of 6 cm. If the patient happens to have a P. D. of 6 cm. and is orthophoric, then the round circle with the arrow above will fuse perfectly with the one marked 6. Whenever we insert or change a card we ask

the patient to close his eyes and then upon opening them to give us the position of the arrow. Suppose he reports the arrow to be over 7 we let him close his eyes, turn 5 degree prism base in on each eye and then ask for a report. For attaining perfect fusion without any stress, we can use for decentration either the + 10.00 D. Sph. or our rotary prisms, or insert loose prisms. The decentration of the + 10.00 D. Sphs. is preferable if the difference is not too great.

Adjusting the Eyes

The next step would be to set the instrument for any vertical imbalance using the B-2 Chart. If vertical balance prevails, the patient may report two circles above and two circles below the horizontal line. Should the report be, one above and 3 below, then we would have a right hyperphoria of 10 degrees to be corrected by 10 degree prism base down upon the insertion of the prism the patient would report a perfect cross.

I personally, however, use right from the start the B-3 card for lining up the instrument.

With the right eye the patient sees the red vertical line with the left eye the black horizontal line. The red line is spaced by letters 5 mm. apart and as the distance to the card is 100 mm., each space corresponds to 5 degrees. The black line is spaced with numbers 10 mm. apart, which spacing is equivalent to 10 degrees the adjustment must be made so that the red and black line intersect at 6 and G. The method of lining up the card B-3 is a wonderful test as to any present vertical hyperphoria.

Method of Procedure

The first series, the A series of cards, is a very rough test as to binocular simultaneous vision or any present suspenopsia tendency of one eye. With this series, I have done very good work in quite a few of my cases. I use these cards mainly for cases of strabismus, just emerging from the state of amblyopia. You have, however, to be careful in checking up the answers. This I do by occluding alternately one or the other eye, sometimes neither, sometimes both, and check up the answers as to what it is he sees, also the eye movements. The relative position of bird in cage also gives a good idea as to any present phoria, though I want to mention here that we do not deal with fusion because we have two unlike objects.

I shall demonstrate here my regular routine, but I do not want to say that this is the only way, or that it is even the best way. Every man develops his own technique after he has been using this system for a certain number of months.

The next group of cards I use is the C group. This group tests in a crude way the ability to fuse.

C1. The two black fields fuse into one. The red and green field must always be seen.

C2. I find very valuable for children. The two ears, and the two eyes of the pumpkin face must be seen. By the report of which one is temporarily lost we can locate the suspending eye.

C3. The two flags on either side of flag pole.

C4. The perfect butterfly.

C5. The rows of numbers. The vertical middle row is the one common to both eyes and serves as the fusion pivot.

C6. The fat man on the bicycle. The lower half to be seen by the left, the upper half by the right eye, and fusion to be attained.

C7. The card ON-NE. The two red letters N must fuse together and the word ONE must appear.

C8. Is one of my favorites. F & L will fuse to E, that is easy, but as soon as we ask for the small letters inside of the big letter E things become interesting. The lowest one will always be recognized as Z, the middle one will be recognized by about 60% as Y, and the upper will be missed by 90 out of 100. It will usually be called an inverted Y instead of an X. I have found that 90% of otherwise normal people will develop a slight suspenopsia for fine details when they look upwards. Maybe the reason is that our gaze is usually directed at about an angle of 15 degrees downwards. It is also very interesting to observe how the criss-cross lines appear and disappear due to the ever changing suspenopsia that takes place in the peripheral fields of either eye.

C9. The last of these series is also a fusion card with very fine details. It is not necessary to use all these cards of one series on every patient. It is sufficient to ascertain quickly by going from the coarse immediately to the finest, the extent of suspenopsia and lack of fusion.

Eliminating Suspenopsia

The next series is mainly to detect and eliminate suspenopsia. The fusion being rather facilitated by the heavy letters. These cards are not only useful in detecting suspenopsia, but serve admirably as a means of combating it. When the patient has become aware of the fact that full attention is expected from him, 50% of all suspenopsia cases are cured. We may safely call most suspenopsia mental visual laziness. Naturally suspension will always occur rather with a patient laboring under the strain of a phoria or a duction insufficiency, than in a normal patient. For this reason suspenopsia, fusion and convergence or divergence training must always be applied simultaneously.

The pictures of this series, as of all others, proceed from the larger types to finer and smaller details.

F1 Fuses to the word God. All control marks are to be called. The O must be observed split on both sides, vertical dash and the central dot must align. If suspenopsia is present try to time it by letting patients say "come and go", with the appearance and disappear-

ance of the control mark. Do not hurry with one card as there is enough material in any card to occupy the patient two to three minutes.

F2. The same word, "God," but the types are smaller and the control marks different.

F3. Still the word "God." Types are still smaller and control marks change.

F4. The word, "Gid." Control marks are the X through the "i" and the dot below the "i."

F5. The word, "Goid." Control marks are the cross in O, hooks above and below O, and dot below the "i."

F6. The same words, "Goid." In smaller prints and different control marks.

F7. The last of these series with the word, "Gicid," and a goodly number of control marks.

I personally do not take the pictures in the regular rotation. For instance, usually the group E, the stereoscopic pictures precede the group F. My reason for changing them around is that I want to be reasonably sure that the patient is not strongly afflicted with suspenopsia, because if he is I surely can not expect any good stereoscopic vision.

Fusion Development

We come now to the group that deserves the name fusion pictures, because the patient must possess the psychic ability to fuse together into one brain image non-corresponding points of the retina.

Whenever I use stereoscopic pictures and I do not get response for depth perception from the patient I increase the prism base out about 6 to 8 degrees and I usually get the desired result. This shows that the patient generally picks that part of the stereoscopic picture which asks for most convergence as his point of fixation. When depth perception is finally established I take the 6 to 8 degree prisms off again. Furthermore I increase and decrease the prism power quite considerably in order that various points of the patient's retinae come under the influence of this fusion faculty. It is quite interesting to note how tenaciously the patient holds on to the depth perception once it is established and that his convergence and divergence are hardly influenced by the alteration of the rotary prisms.

E1. Has to be recognized as an inverted pail with the smaller opening towards patient. The dots and the small circle are to be seen at various depths.

E2. Should be seen as a dishpan with two handles with bottom towards patient.

E3. Is a pan with patient looking into it.

E4. It is not easy to be recognized as the perspective is very deep and the retinal points which have to be fused are quite a distance

apart. Prism base out usually turns the trick and a deep tunnel is seen.

E5. Is very instructive. The two arrows must fuse into one, but from their position you can readily see that if their pictures shall fall on what is commonly known as conjugate points, each eye would have to rotate through an angle of 15 degrees which of course is impossible. When fusion is established the patient will see the arrow directed towards him. Let us consider this phenomenon. When we look at a rod directed towards us, and we project the picture each eye receives, then we will have the same condition as shown on this card. The left eye sees, the rod from upper left to lower right, and the right eye, from upper right to lower left. This card therefore unlocks a remembrance act based on former experience and thus brings about fusion.

E6. Is somewhat similar. The arrows first appearing in one plane will eventually turn the upper one away and the lower towards the patient.

Cards E7, E8 and E9 are to be recognized as solid bodies.

Perspective

Card E10 is a splendid test for perspective. The various objects are to be called off according to their distances from the patient. Starting with the nearest one they are: 5, 3, 4, 9, 1, 7, 2, 8, 10, and 6.

The series G is a continuation and amplification of series F. The cards contain words and sentences which can only be read when both eyes are constantly seen and no suspenopsia is interfering with fusion and true binocular vision. This series is very much like the bar reading which we shall explain later on. The control marks are gradually diminishing in size and demand ever present vigilance in order to be recognized and called.

Muscle Training

The next series, I, is the series used for training the extrinsic muscles. As a fixation object we have the word ONE split into two parts, ON and NE. When we choose the card mark 6 cm. on which the distance from center to center of N is 6 cm., it should be fused without any effort as the instrument is set for this distance.

Convergence and Divergence

Convergence and divergence training can be done in different ways, individualized as to patient and operator. I shall describe a few which I mainly use.

For instance, convergence exercises: Put light tension on inner rectus with prism base out. Then, using the card the moment you increase prism occlude patient's eye over which prism is increased. When the eye is reopened it meets a different prism power than before occlusion had taken place and, in order to restore the word ONE, the fusion area around the macula is called into action. If the patient

finds himself slipping, he is ordered to say "Two" or "BROKE" and, by reducing the prism power, the word ONE is picked up again. When the increase in prism power has gone beyond 5 degrees we can change the cards using the 5½ cm. card and reduce the prism power 5 degrees. The increase during occlusion can be individualized as to the general strength and health of the patient. When a good adduction is reached it is well to give occlusion a few times with the same prism power before proceeding to increase it. The eyes of the patient are to be watched during procedure.

Whenever I can, I introduce the following method: After the muscles are under stress I explain to the patient that one tap on his shoulder means "close eyes" and two taps "open eyes." When he can restore the word One then he is supposed to say "ONE." Otherwise he is to report "BROKE." Patient has to be given one or two seconds to restore fusion before he is helped by the reduction of prisms. The longer the patient has his eyes closed, the harder it is for him to restore perfect fusion. This treatment can, therefore, also be highly individualized. I find that this procedure has a strong appeal to the competitive spirit of the patient and invariably brings about splendid co-operation.

Length of Treatments

The treatments should not be of long duration, but rather frequent. If possible, give treatments at the beginning twice a day, or at least once a day, not exceeding 15 minutes, which time is to be governed by the signs of fatigue on part of the patient.

The amplitude of fusion or convergence should be built up to at least 65 degrees, if possible to 85 and more. A certain loss is to be expected and therefore a building up beyond the normal is desirable.

The divergence exercises are to be handled in a similar way, only that the increase during occlusion is to be somewhat smaller as the total abduction is only about one-third of the total adduction.

Sometimes, although very rarely, a patient has no trouble with convergence in the median line, but finds difficulty in converging points outside the median line. These cases should then be treated in the direction at an angle to the median line. For this purpose the two rotary prisms are turned with the same power to the same side, thus shifting the object ONE to one side and exercises are then given in this direction. Instead of this procedure, equal power auxiliary prisms can be inserted in the lens cells of the instrument.

In case of strabismus with minimum visual acuity of 20/60, the card that can be fused the easiest shall be chosen and prism base in exercises applied.

The last series is series H, which combines convergence and divergence exercises with suspenopsia control. The exercises are to be conducted in the same way as the exercises with the I series and great care has to be taken that all the control marks are called.

I want to mention again that it is not absolutely necessary to use all the cards on one patient. One or two of each series is enough to find out where the fault lies and then we can specialize on the series which is adapted for this particular patient's case.

For Children

Quite recently, there has been developed a children's series of cards by Dr. Wolf. This series, I think, is of remarkable benefit. The pictures are about children's stories and immediately arouse the child's interest. As you know, psychology has a great deal to do with fusion and the fact that the child is well acquainted with the story connected with each picture helps its fusional effort tremendously by the assistance of the memory. The two pictures of each card are also spaced various distances apart and enable, therefore, the refractionist to use them for different cases. The cards are also very effectively colored which also helps to bring about fusional stimulus.

Home Exercises

The subject of home exercises is a chapter in itself. Success depends very much upon the intelligence and the co-operation of the patient. Any home treatments that are not carried on intelligently are more of a detriment than a help. The average commercial stereoscope is usually out of alignment. Every stereoscope should, therefore, be carefully tested, especially for vertical imbalances.

The patient should be tested out on the stereoscope he is to use for home work with the B-3 card, the red and the black line card, and its easiest fusion distance determined. The proper card for this distance should then be given, or the fusion distance should be attained by auxiliary square prisms in the clips of the stereoscope. The patient should receive a typewritten explanation how often, when and in what manner the home exercises are to be carried on. Various cards, not too many, though, and one or two auxiliary prisms ought to be supplied. At any rate, the home treatments should not be carried beyond the scope of the last office treatments. They should merely serve to solidify the ability acquired by the office treatments. The office treatments must remain the main part of the cure.

Controlled Reading

There is a splendid and very simple instrument on the market which allows a very effective cure for persistent suspenopsia. This instrument is the Wells reading bar and I am highly surprised to have found how little it is generally used. The Wells reading bar consists of a flat thin bar of very pliable material, which bar is suspended from a head band. The reading rod is hung over the good eye and is adjusted so that it can create a black streak through the printed page for this eye. If the other eye would not function simultaneously the patient could not read on as the print occluded by the rod cannot be read by the good eye. Thus the patient is forced to simultaneous and

also single binocular vision and the condition of suspenopsia is removed. Care must be taken that the reading bar actually interferes with the field of vision of the good eye and does not fall outside, as may be the case with narrow newspaper columns. Another condition is that the patient reads along the line by moving the eyes only and not the head, as this latter may again offset the interference by the rod. These bar reading exercises are purely home work and should be caried on by the patient every evening during his reading hours.

When to Prescribe Prisms

The great question is always when shall we give exercises and correcting prisms? The latter should only be given when exercises are utterly impracticable, as for instance in old age, or due to the inability of the patient to attend the exercises. Vertical imbalances should be attended to only after the present lateral imbalances have been corrected by exercises or prisms. In many cases the vertical imbalances straighten out after the lateral ones have been properly taken care of. Whenever possible, exercising prisms have to be given the preference to relieving prisms which latter ones very often tend to aggravate the condition. Our clinic at the Pennsylvania State College of Optometry under the leadership of Dr. Edwin Tait has worked out a very simple formula which gives us a good clue when we may expect trouble from any present muscular imbalance. The nature of muscular imbalance is first ascertained and the ductions contra to this imbalance are then determined by working the duction prism, first on one eye and then on the other. These ductions are referred to as adduction left, adduction right or abduction left and abduction right where we are well aware that this is a misnomer and that the duction cannot be taken monocularly.

The following quotient is then formed: Numerator = present phoria; denominator = present phoria + contraduction right + contraduction left and when this quotient is larger than ¼, trouble in maintaining single binocular vision may be expected.

The following are two examples:

Es. 6
Add. R. 16
Add. L. 12

$$\frac{6}{6+16+12} = \frac{6}{34}$$ which obviously is less than ¼

Es 5
ABDR 6
ABDL 4

$$\frac{5}{5+6+4} = \frac{5}{14}$$ which obviously is more than ¼ danger

Another safe question presents itself as to the nature of the prism exercises whether base in or base out, because this nature is not always determined by the phoria present. After all, the muscle work is only one phase of the refraction and its result must be considered in conjunction with the entire examination, especially the dynamic retinoscopic findings. An esophoria may be functional due to latent hyperopia or may be true. Frequently even an exophoria is the result of latent hyperopia due to the fatigue of innervation of the internal rectus or inhibition of the external rectus. We may safely say that in the presence of latent hyperopia disclosed with the dynamic retinoscope at 13″ prism base in exercises are always proper, no matter what the condition of the phoria is. Inhibition of the nerve fibres is just as stimulating as innervation. Each case presents its own problems and can only be solved by co-ordinating the findings of all tests.

Dr. Edwin Tait in our clinic of The Pennsylvania State College of Optometry is conducting at present very extensive research work as to the flexibility of the fusion sense. All kinds of various cards are devised to determine the limits of fusion ability and it is quite surprising to observe to what extent this sense can be trained. In my estimation the time will come when ocular calisthentics with fusion pictures will become a requisite of every school. In view of the fact that 70% of all our school children will be forced to make their living working at near fusion limits, the demand to train their fusion sense to the utmost is almost imperative.

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A METHOD FOR REDUCING PSEUDO-MYOPIA

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I present herewith a practical method for reducing pseudo-myopia in cases where the fusion faculty is well developed. Using the principal of orthoscopic lens in which both accommodation and convergence are reduced to *0* while the patient is viewing an object at a near point.

This method embodies three very important factors in ocular exercise:

(1) Attention and interest of the patient.

(2) Binocular rotation and fixation.

(3) Periodic exercise and rest.

The particular application of this method is, I believe, new. The principal under which it operates I can not claim credit for.

We have made up a series of cards 3½x7 inches, and have placed in the corners and in the center of each card a letter, number, or small picture. During the examination period the card is placed at twenty inches on the phorometer rod, and must be so situated that the whole of the card may be observed with each eye. A wide aperture phorometer is necessarily more efficient, as it allows a wider angl of rotation.

The patient is instructed to memorize the card. You will observe the rapid rotation and fixation which takes place while the patient is commiting it to memory. When the card is memorized, instruct the patient to close his eyes. Next remove the card or rotate it on the rod carrier so that it is no longer facing the patient, and ask the patient what was in each of the corners and in the center. If you check the answers carefully and show the patient his mistakes, he will feel ridiculous and will work harder next time. I believe that only while a maximum of mental effort is taking place can we get the quickest and best results in our ocular calisthenics.

To relax pseudo-myopia, place the subjective distant prescription in the phorometer, the card at twenty inches, and place prism base-in equal to M. A. of Con. (P. D. 60 mm. = 12 prism dioptres base-in) so that the convergence is 0. Increase the plus sph. until the card is slightly hazy, and continue to exercise. As accommoda-

tion relaxes, replace it with plus sph. It may be found necessary to cause the eyes to diverge slightly beyond parallelism to completely relax accommodation. When the plus sph. is equal to the dioptic equivalent of the distance of the card with the card at twenty inches (a plus 2 sph. will relax accommodation sufficiently to render distant vision clear if card is seen clearly at twenty inches). The next step is to reduce the prism base-in while a plus 2 D. Sph. is before the patient. The patient must converge for the card and relax his accommodation sufficiently to see the card clearly. Check results on Jaeger chart. It will be noted that in this last exercise we are relaxing or holding back accommodation and stimulating convergence, while in the first exercise we were removing the convergence support of accommodation and thus bringing out the true defect.

Fifteen minute exercise periods and graduate prescriptions to keep up with latent errors revealed is recommended. Small figures on the cards are valuable in that they insure relaxation of Accommodation.

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OCULAR PSYCHOMETRY

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CHAPTER 10

When in the course of a regular optometric examination, the visual acuity of an eye is found to be below the accepted standard, after the error of refraction has been corrected with proper lenses, the condition is described as "Amblyopia."

When no pathologic condition can be held responsible for the dimness of vision, and especially if the eye has for some time had an uncorrected error of refraction, the condition is described as "Amblyopia-Exanopsia."

Literally, the name means "dim vision from dis-use"—an eye that has never learned to see acutely or else has "forgotten how." In either case, the condition is considered to be acquired.

Worth[44] expresses the opinion that congenital amblyopia is very seldom met with. He further states that amblyopia is a true loss of vision, not a failure of the function to develop, and that it is acquired before the sixth year.

It has been frequently erroneously stated that an amblyopic-exanopsic eye cannot be restored to normal visual acuity after the patient has passed fourteen years of age. The only reason advanced is that in an older patient, the progress of restoration is so slow that the patient's cooperation cannot be secured and maintained for a sufficient length of time. Therefore, we believe optometry is to be congratulated on having developed a technique which not only shortens the development period in children, but is equally effective in much older cases and has been frequently reported successful with patients well along toward the sunset of life.

The characteristics of amblyopia-exanopsia, which must be borne in mind if the condition is to be successfully corrected, are:

First, unlike other forms of vision failure, it seldom involves more than central or para-central vision; acuity in the extra macula areas remain normal and in some cases even above normal. (See table of normal indirect acuity given in Chapter 7.)

Second, amblyopia-exanopsia differs from toxic amblyopia (dim vision, due to pathologic disturbances) in that the fundus is not visibly affected, whereas pathology sufficient to affect the vision always disturbs the normal color fields and generally leaves some visible trace upon the fundus discernible through a careful ophthalmoscopic examination.

Third, acquired amblyopia may be of any degree, gradually growing worse until even total blindness of the central area may result. Whereas, loss of vision in pathological conditions are usually much more rapid, while in congenital amblyopia there is practically no change either for better or for worse.

A record of normal acuity assumes:

First, that an image has been properly focused upon the macula.

Second, that the retinal elements have responded to adequate stimuli in a normal manner.

Third, that as a result of the cell response, impulses have been transmitted to the occipital cortex, the cuneus particularly.

Fourth, that the patient's previous experience and intelligence permit him to describe correctly the conception gained.

Inasmuch as this is being addressed to optometry, it may be assumed that the first factor, a sharp image upon the macula, is assured; and it must be assumed that we have in consultation a patient of sufficient intelligence to correctly describe visual impressions properly received although in extreme cases of amblyopia-exanopsia, it sometimes happens that an unquestionably intelligent patient is unable to describe quickly the impressions received through a long dormant eye.

Having determinated by elimination through case history the use of the ophthalmoscope and parametric explorations, that the case is truly amblyopia-exanopsia and being assured that the proper ametropic correction is in place during the exercise and training, our problem becomes chiefly that of providing normal response of the retinal elements and a possible improvement of the neuron path from the retina to the brain.

The normal response of the retinal elements in form conception is beautifully described by F. Treacher Collins[45] in the following paragraph:

> "If we could examine the outer surface of the retina so stimulated, under sufficient magnification, a reproduction of the letter looked at would be seen raised up and composed of the unretracted outer limbs of the cones."

A few moments' consideration of the above paragraph brings realization that in order to correctly interpret the test letters, it is necessary for certain cones to respond while those immediately adjacent remain unresponsive. That is, if the object of regard be a black line upon a white surface, it would be necessary for the cone on either

side of that line to respond without affecting the cones upon which the black line was actually focused.

If we now consider that an uncorrected error leaves the retinal image out of focus so that there can exist no sharply defined lines between light and dark, we realize that the amblyopic-exanopsic eye has never had an opportunity to exercise certain cones while adjacent cones remain at rest.

To the contrary, the cones of the ametropic eye have always been required to move "enmasse," that is, in groups so that when a sharp black and white image is focused upon the amblyopic retina the cones meet with difficulty similar to that encountered in an attempt to clinch the little finger without affecting the other fingers of the hand.

The first step in developing amblyopia, by the most advanced technique in corrective optometry, is to exercise the cells of the retina by exposing the eye alternately to light and darkness at rhythmically measured intervals, and inasmuch as the complete action of the cone requires something less than 1/5 seconds, any frequency less than five alternations of light and dark per second, especially if the light be of sufficient intensity and the darkness practically complete, stimulates full action of the retinal cells.

There are at present three principles which may be adapted to this form of stimulation.

In one instance, a beam of light is projected toward the patient's eye from a distance depending upon the patient's sensitiveness to light. The light is then caused to move across the patient's eye so that the eye is flooded with light, then left in darkness for equal periods; light and dark alternating with mechanical rhythm. It has been frequently demonstrated that by this simple technique, visual acuity may be improved to a degree in almost every case regardless of the cause of the dim vision.

A step farther in this direction has been taken by providing means of causing well defined images to be exposed in measured contrast to their surroundings, for a measured period of time, and then to disappear; leaving the patient's eyes in the darkness for an equal period. The alternations being repeated with exact rhythm.

The second phase of training, makes use of the usual phenomena that in amblyopia-exanopsia, the peripheral field is not affected. A chart with test figures of various sizes and forms is placed before the patient in a darkened room. A projected light from the myoculator is now caused to move in any selected pattern of motion to and fro across the targets while the patient is attempting to decipher the test letters in the intermittent illumination.

While involving the first described principle, this technique also provides that indirect vision is being constantly stimulated by a moving light (above all things the most difficult to suppress) while atten-

tion is being focused upon direct vision. The correct description of the characters being demanded, the patient is forced to attempt suppression of the peripheral field while retaining awareness of the central field; thereby, reversing his former habit suppression of direct acuity only, which habit is characteristic of the amblyopia-exanopsia. This reversal of effort brings direct and indirect visual attention nearer the normal relative balance.

The next phase of development is directed more definitely toward the improvement of interpretation. It embodies the principle of comparison. Inasmuch as the amblyopic-exanopsic patient usually has one eye with normal acuity, while the companion eye is at fault, by exposing a selected figure first to the good eye then to the bad eye, the mind is repeatedly presented with a model of that which should be "seen" through the subnormal eye. For example, consider a figure moving from right to left and observed by the patient whose eyes are disassociated by means of a septum. The figure visible to right eye only for an interval, then moves into the field where it is visible to the left eye only for a like period.

Another means employed is a figure, moving or stationary, which changes from red to the complement green, at selected intervals, viewed by the patient while wearing a green light-filter before one eye and a red light-filter before the companion eye. This figure is visible, then invisible, to each eye in turn because the light from it is complementary to the first one better than the other.

A third means consists of two fixation objects, one for each eye, the eyes being disassociated either by means of a septum or complementary colors, the figures appearing and disappearing at rhythmic intervals.

Most of the earlier methods employed in the development of amblyopic eyes were negative rather than positive. That is, no particular means were employed to improve the "amblyopic" eye except to provide an approximate refractive correction; while the "good" eye was handicapped with a frosted lens, smoked glass, an eye patch or atropine to inhibit normal activity. Only two of the earlier practices are commendable to modern optometry. One is the practice of having the patient transcribe from a suitable text while using the amblyopic eye only; the good eye being covered with an eye patch. Inasmuch as this is essentially home work, it is imperative that the optometrist require his patient to bring the copy to the office and that the patient be required to do sufficient copying to insure attention to the amblyopic eye for a sufficient period, say, thirty minutes each day.

The other commendable exercise requires the patient to give close attention to a receding target while the good eye is occluded. The usual method employed is to have the patient stand as near as necessary to a suitable chart, the good eye covered, fix attention upon the

center of the smallest recognizable letter, and then back slowly away from the chart until recognition of the letter is no longer possible.

Improvement is probably due to the gradual reduction in size of the macular image which has already been properly interpreted; but a very valuable feature of the exercise is that it permits the patient to observe the progress of his own improvement. He is greatly encouraged to find that he "gained a foot yesterday and two feet today" in the distance at which the letters are clearly discernible.

As the amblyopic eye improves, there is a tendency to continue suppression in actual daily use although suppression has been overcome under test conditions.

Excellent exercises for office and home use to overcome this tendency, employ the principle of Javel's bar reading test. The patient is required to read books, newspapers and the like with a narrow obstruction, such as a pencil held about half way between the eyes and the page. "The control bar reading device" described by Wells is excellent for this purpose. It consists of two or three prongs attached to a head band in such that they are suspended between the patient's eyes and the reading matter. Each narrow obstruction so placed before the patient's eyes obscures part of the print to one eye and another part to the companion eye, forcing the patient to give recognition to both eyes in order to read uninterruptedly.

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A REVIEW OF A FEW OF THE MORE RECENT IMPROVEMENTS IN TEST TYPE WITH PARTICULAR REFERENCE TO CHARACTERS USED, AND THE FINDINGS OF BANISTER[1]

After reviewing the previous work of Hay,[2] Sheard,[3] and Hartridge and Owen,[4] Banister reports the findings of a series of experiments recently conducted at the Psychological Laboratory of the University of Cambridge on testing the most accurate means of measuring visual acuity, by means of block capital letters.

His experiments lead him to classify certain letters of the alphabet in specific groups, these groups being as follows; the letters C, D, G, O and Q in the first group; the letters H, K, M, N, and W in the second group; and the letters A, D, E, F, I, J, L, M, X, and Z in the third group. The first and second group he finds are letters which are easily mistaken, one for the other, while the letters in the third group are what he terms "individual" letters, or letters whose general outline is sufficiently distinctive so as to not make them easily confused, one for the other.

Banister therefore recommends the use of letters in group one, or group two, or both groups together for use in sight testing charts claiming that inasmuch as the object of a visual acuity test is to determine detail of visual perception and that inasmuch as the letters

of the first two groups are easily confounded one with another, that the object of the acuity test is best carried out by their use.

On the assumption that Banister's findings are correct, the writer has prepared a review of the charts as suggested by recent experimenters with particular reference to the characters used on these charts and in comparison of these characters with the findings of Banister.

Ryer[5],[6] has devised a set of block letter test characters set in crossed-lines, each marking the one-minute intervals. In other words each block letter is drawn in its square consisting of intersecting lines subtending five minute angles. These lines are so arranged that they are unnoticed when the character is in good focus, but prevent successful guessing when out of focus, as the squares will cause nearly all of the characters to blur in such a manner as to look more or less alike. Ryer also suggests that the test characters be spectrum red in color on a flat white ground. The advantage of this arrangement being, he claims, that red having the longest visible wave length affords the maximum plus and the minimum minus correction in hyperopia and myopia respectively. The characters, he further recommends, should be numbered for visual acuity in both Snellen fractional and percentage, and should be so arranged as to show but one set of characters at a time.

Ryer uses block figures as well as block letters in his chart, his choice being as follows:

First Chart, 300-foot letter:

C

Second Chart, 200 foot letter:

E

Third Chart, a 140 foot letter and a 100 foot letter:

T L

Fourth Chart, four lines of characters, the first an 80 foot line, the second a 60 foot, the third a 50 foot, and the last a 40 foot line of characters, as follows;

P 5 D
S Y 8
E H P 4
F B D R 2

Fifth Chart, four lines of 30 foot characters, the third line being an illiterate test with the letter E in different positions, the other lines being:

8 2 7 4
H P S F
0 5 8 3

Sixth Chart, four lines of 20 foot characters, the third line again being the illiterate test, this time using the letter C as well as the letter E in different positions. The other lines are as follows:

B 8 D F
3 9 2 5
8 2 7 4

Seventh Chart, four lines of characters, the first being a 30 foot line, the next a 20 foot line, the third a 15 foot line and the last a 10 foot line, as follows:

3 5 8 4 2
F B P 6 9 7 5
H 2 P L N 4 Z C V F
8 Z 2 O B S 3 F O P 4 E Y 7

Ryer, in his set of charts, includes three others, these being an astigmatic fan, a fixation chart and a kindergarten test chart.

It is interesting to note that Ryer uses, in block form, all of the letters of the alphabet except the A, G, I, J, K, M, Q, U, W, and X, and all of the figures except 1 and 0. His use of twenty-four characters gives the examiner the widest range of any of the newer charts reviewed.

In comparing Ryer's choice of test characters with those suggested by Banister in group one, it will be noted that Ryer uses the letters, C, D and O, but does not suggest the use of G and Q, and comparing his choice of letters used with those in group two of Banister it will be noted that he uses H and N but does not use K, M or W. It will also be noted that Ryer suggests the use of just half of the so-called individual letters mentioned in group three, those used being D, E, F, L and Z.

Wiseman[7] has devised a chart in which the letters are not arranged in horizontal rows, but rather in staggered divisions thus making it quite impossible for patients to memorize much of the chart. Furthermore, the characters in each division are carefully calculated as to size, certain letters which are difficult to distinguish, being made larger in size than others which are more legible. For instance, the letter B being one of the most difficult letters to distinguish is made nearly a third larger in size than the letter O, an easy letter to distinguish, when both are placed in the same group. Each letter or figure used has been carefully calculated to size for each group of division, this research work being done under the supervision of Wiseman by the Tri-City Optometric Society.

Wiseman also suggests a change in arrangement from the standard grouping of letters by foot-distances into newer groups, these arranged into divisions by percentage of acuity of vision, his chart to be used at 20 feet, having thirteen such divisions ranging from 10% visual acuity (200 foot characters), to 150% visual acuity (13.3 foot characters). The characters used by Wiseman in his staggered divisions are as follows:

First Group, 10% visual acuity:

P B
Second Group, 15% visual acuity:
S E
Third Group, 20% visual acuity:
R B O
Fourth Group, 30% visual acuity:
B O K T 2
Fifth Group, 40% visual acuity:
H P G S B O
Sixth Group, 50% visual acuity:
B R D 5 O L
Seventh Group, 60% visual acuity:
3 E B N O T
Eighth Group, 70% visual acuity:
R 9 P B V O
Ninth Group, 80% visual acuity:
4 N B Z O L
Tenth Group, 90% visual acuity:
S E R Y O B
Eleventh Group, 100% visual acuity:
2 B O S T U
Twelfth Group, 125% visual acuity:
F K G B
Thirteenth Group, 150% visual acuity:
B O

Wiseman's chart also includes a set of the Broken Ring test objects in various sizes as well as an astigmatic fan with 10° separations.

In comparing Wiseman's choice of characters with that of Ryer, one finds that Wiseman uses more of the letters in block form but fewer of the figures, he using all of the letters of the alphabet except the A, C, I, J, M, Q, W, X, and Y, and all of the figures except 1, 6, 7, 8 and 0. Wiseman's chart thus gives the examiner a range of some twenty-two characters.

In comparing Wiseman's choice of test characters with those suggested by Banister in group one, it will be noted that Wiseman used the letters D, G and O, but does not use C and Q, and in comparing his choice of letters used with those in group two of Banister it will be noted that he uses H, K and N, but does not use M or W. It will also be noted that Wiseman suggests the use of just half of the individual letters mentioned in group three, as did Ryer, those used being D, E, F, L and Z.

Tallman[8], in an effort to make a chart which could be used for both direct distance as well as the distance-doubling mirror system,

suggests the arrangement of a chart using only the following characters, H, T, M, Y, A, V, W, U, I, O, X, and 8, all of which would appear the same regardless of technic applied. Charts made up in this manner naturally limit the examiner to but twelve of the usual block characters, but permit him the additional advantage of use, with or without a mirror.

In comparing Tallman's naturally restricted choice of test characters with those suggested by Banister in group one, it will be noted that only the letter O applies to his limited test chart, the letters C, D, G and Q not appearing, being non-reversible characters, and comparing his limited choice of letters used with those in group two of Banister, it will be noted that he uses H, M, and W, being unable to use K and N. It will also be noted that Tallman uses the individual letters mentioned in group three as follows, A, I, M, and X being appliable in his chart.

Laurance[9] suggests the use of the "Orthops" Chart for subjective sight testing and recording the acuity of vision. The chart has the usual lines of block characters from the 200 foot line to the 10 foot line the arrangement of the characters being as follows:

E
C F
B D E
Z P N O
D B P C R
P F E R S N
E N Z L C O H
L Z O E D T F P
H P Y S T X R U L
O C X H G P D E U T N Z

The Orthops Chart also includes a movable axis finder for astigmia as well as an astigmatic fan with very heavy 10° separations. As can be observed, this chart makes use of only letters for its characters, its maker ignoring entirely the figures, using, however, eighteen of the twenty-six letters of the alphabet in its make-up, omitting only the A, I, J, K, M, Q, V and W.

In comparing this chart with the chart of Ryer, we find that the Orthops chart embraces the use of three letters not used by Ryer, namely the G, U and X, while not using the V as used in the chart of Ryer, and in comparing it with the chart of Wiseman, we find the Orthops Chart using the letters C, X and Y not used by Wiseman, while he uses the letters K and V not embraced in the chart made in England.

In comparing Laurance's choice of test characters with those suggested by Banister in group one, it will be noted that Laurance uses the letters C, D, G and O, but does not use the Q and in comparing his choice of characters used, with those in group two of

Banister, it will be noted that he uses the H and N, but does not use the K, M and W. It will also be noted that Laurance suggests the use of the individual letters, D, E, F, L, X and Z as mentioned by Banister in group three.

Beach[10] has devised a set of test characters composed of four divisions. The first is a combination of the broken ring test and the letter O in various sizes. The second division, which he calls his confusion chart, is composed of many acute angle test characters, all letters, arranged in the usual rows. The third group or division of his chart is composed of the letters N and Z, the elements of these letters being but one-half the usual thickness and the space between them equal to but one-tenth of their height. The fourth division is composed of Maltese crosses of various sizes. These last two divisions being used for subjective tests particularly with reference to astigmia.

The test characters used in group two by Beach are as follows:

E
D W
B E M
R F K A
D B X Y
G D P H M E
D O F B K W
C D B R K A X V
D O C F R K X Y M N

In reviewing the chart of Beach it is interesting to note that he uses no figures and more of the letters of the alphabet than do Ryer, Wiseman or Tallman, and the same number as used by Laurance, Beach using all of the letters but the I, J, L, Q, S, T, U and Z, the later letter while not employed in the second division of his chart, is however used in the third in conjunction with the N as already mentioned.

In comparing this chart with the chart of Ryer we find that Beach embraces the use of letters not used by Ryer, namely, the A, G, K, M, W and X, while not using the L, S, T and Z as used in the charts made by Ryer, and in comparing it with the chart of Wiseman we find Beach using A, C, M, W, X and Y not used by Wiseman while he uses the letters L, S, T, U and Z not employed in the chart of Beach. And in comparing his chart with that of Laurance, we find Beach using the A, K, M, V and W not used by Laurance, while Laurance uses the L, S, T, U and Z not incorporated in the chart of Beach.

And, finally, in comparing the characters of Beach with those suggested by Banister in group one, it will be noted that Beach uses the letters C, D, G, and O, but does not use the Q, and in comparing his choice of characters used with those in group two of Banister,

it will be noted that he uses them all, the H, K, M, N and W as suggested by the latter. It will also be noted that Beach suggests the use of the individual letters, A, D, E, F, M and X as mentioned by Banister in his third group.

To refer solely to the test characters of the Ives' Visual Acuity Apparatus and the few characters used with the Clayson instrument we find them averaging in the main with those used in the charts of Ryer, Wiseman and Laurance. The choice of characters used, in all these, apparently being governed by the individual tastes of the designer. Beach attempts to pick characters which have acute angles, and in doing this, his chart contains more of the characters mentioned in groups one and two of Banister than do any of the others, yet his arrangement does not follow out the findings of the experimental work of Banister, *i. e.*, that each group be used together as a unit, rather than mixing them up, both together and with the individual letters as mentioned in Banister's group three, as done by Beach. A rearrangement of the chart of Beach, using the same characters but in the different groups as suggested by Banister would result in something like the following:

M
H K
W N M
C D G O
G O D C
K N W M H N
M W N H K M

The first three rows of characters, for instance, being composed of letters which comprise group two, the fourth and fifth rows composed of the letters of group one as used by Beach, the sixth and seventh rows again formed of letters from group two, etc.

Such arrangement would naturally eliminate the more easily discerned characters of group three, the individual letters, but would at the same time enable an examiner to check the acuity of vision with a chart using only groups of characters composed of letters which are easily mistaken, one for the other, thus improving the accuracy of these findings.

Banister also suggests exposing but one letter at a time, this letter to be exposed but for a fraction of a second, thus, he claiming, more nearly approximating the normal use of the eye. This would be somewhat impractical in the diagnostic room, but the various charts of Ryer would seem to lend themselves splendidly to this plan, each chart being easily arranged to contain only letters of either group one or two. Ryer's use of the lines blocking each letter off into twenty-five one minute angle squares would apparently add even more to

the accuracy of the test for those who wish to use test characters for checking the acuity of vision of their patients. C. C. K.

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THE DOMINANT EYE. A. S. Lidiard, F. B. O. A. (Hons.). The Dioptric Bulletin (British). Vol. XXIX, No. 9, pp. 520-528. 1927.

Lidiard, a British optometrist, claims that the relation of the visual axis is usually represented by an isosceles triangle of which the internodal line is the base, the point of fixation being on the bisector perpendicular to the base. The visual axes are thus equally inclined and the distance of the fixation point from the nodal point of each eye is the same. Such diagram assumes that each of the two eyes plays an equal part in binocular vision. This is undoubtedly true in a minority of cases, but in those cases in which one eye is definitely dominant the visual triangle is more correctly represented by a right angled triangle, in which the base is the internodal line, the perpendicular is the visual axis of the dominant eye, and the hypotenuse is the visual axis of the secondary eye. The distances of the fixation point from the nodal points of the two eyes are not equal.

If, claims Lidiard, a (naturally or artificially) emmetropic subject with pronounced dominance of one eye looks at a distant object near his limit of visual acuity and plus lenses are placed before his dominant eye he will at once complain of fog, whereas much more plus can be placed before the non-dominant eye without complaint of fog or confusion. Similarly, if minus lenses be used the subject will usually notice minification more readily when the lens is before the dominant eye.

If the object of regard is at reading distance such a subject will, especially if presbyopic, appreciate small additions of plus or minus lens power over the dominant eye much more readily than similar additions over the non-dominant eye.

The clinical application of the foregoing division of labor is twofold: Firstly, as it affects the measurement of ductions and tonicity tests. Secondly, as it affects the prescription of lenticular and prismatic corrections.

Ductions are variously measured by rotary prism power divided between the two eyes, by prism power all before the right eye, and by prism power all before the left eye. On the same patient the three methods may give different readings, in particular may the reading vary when all the prism power is before first one eye and then the other.

Careful comparison of the records of a number of cases shows that, in general, when the prism is all before the non-dominant eye, that is, when the dominant eye is permitted to see the test object normally in its proper position in space, the measure of the ductions is greater than when the prism power is otherwise distributed, and, further, that repeated readings are more consistent.

If, on the other hand, all the prism power is placed before the dominant eye, the non-dominant eye fixing, the measure of the duc-

tions is usually not so great, and, further, repeated readings show a greater tendency to vary. Assuming the dominance of one eye this is, he claims, what we should expect. In the former case where the dominant eye is fixing the test object directly in its proper spatial position and the other eye is doing all the turning necessary to prevent diplopia, both eyes are working under conditions similar to those under which they normally function. In the second case, neither eye is working under conditions comparable to the normal. It is not, therefore, surprising that we should get varying and inconsistent data. It would thus seem advisable, claims Lidiard, on the ground both of naturalness of conditions and for purposes of comparison that ductions should always be measured with all the prism power on the non-dominant eye.

In making tonicity tests also, Lidiard finds it advisable to always place the rod over the non-dominant eye, claiming that the readings from examination to examination will be more constant. He, too, follows Sheard in advising that where possible all the prismatic correction should be placed over the non-dominant eye.

He gives the following technic in determining the dominant eye. The simplest of all is to have the patient, with both eyes open, extend his finger and arm and point at any narrow vertical object, say, a blind cord or edge of window, and having done so, to say with which of his eyes his finger and the vertical object are in alignment. This test has not, in the writer's experience, proved very satisfactory, probably in part on account of the influence of right-handedness or lefthandedness. It is also handicapped by being a subjective test.

A much more satisfactory test, which is partially objective, is to have the patient hold a pencil vertically in the forefinger and thumb of both hands, arms extended downwards. Keeping both his eyes open and fixed on one of the examiner's eyes (the examiner's other eye being closed) the patient raises the pencil vertically in line with the examiner's open eye. The eye of the patient which the examiner perceives to be in alignment with the pencil is a dominant one.

A more precise test is to use a sheet of metal or zylonite or similar material with a circular aperture of about 1 inch diameter in the centre. The patient holds this sheet, in both hands, and fixing the examiner's open eye as just described raises the sheet slowly into such a position that the examiner's eye appears to him to be in alignment with the aperture. That eye of the patient which appears to the examiner to be in alignment with the aperture is dominant.

His paper closes with the following summary: (1) In the majority of subjects one eye is dominant, performing the function of directing the binoculus and controlling accommodation, the function of the other eye being motion to produce binocular single vision. (2) Where one eye is dominant, it is desirable in duction and tonicity

tests at distance and near that the direct fixation by the dominant eye of the test object in its true position in space should not be interfered with, hence measuring prisms and dissociating devices should be before the non-dominant eye. (3) For similar reasons, when prism assistance is given it should normally be placed entirely before the non-dominant eye. (4) Whenever possible the acuity of the dominant eye should be made equal to, or better than, that of the other eye. (5) Location of the dominant eye occupies so little time that it may readily be included in consulting room routine.

T. O. B.

THE ULTRA-VIOLET, VISIBLE AND INFRA-RED REFLECTIVITIES OF SNOW, SAND AND OTHER SUBSTANCES. E. O. Hulbert. Abstract in the Journal of the Optical Society of of America. Illustrated. pp. 23-25. Vol. 17, No. 1, 1928.

Hulbert makes a series of controlled investigations as to the reflecting ability of various substances for the ultra-violet, the visible and the infra-red rays. Among the materials tested were sand and snow and his experiments show that sand reflects from two to four times as much of the heat rays as does snow, while the latter reflects from two to four times the amount of ultra-violet reflected by sand, at the same time being itself a very poor reflector of the long infra-red or heat rays.

C. C. K.

BOOK NOTICES

THE PHOROPTOR: ITS USE IN OCULAR REFRACTION.

Published Anonymously by the American Optical Company. Southbridge, Mass. 214 pages. Illustrated. $2.00. 1928.

Static skiametry, dynamic skiametry, subjective testing, tonicity tests, duction tests, accommodative convergence and fusion convergence tests at the near-point, presbyopic check tests, the measurement of accommodative reserves and the use of the cross cylinder are subjects dealt with in this new work anonymously brought out by the American Optical Company. The book, to be sure, was written to illustrate the advantages accruing to the optometrist in using the phoroptor, but the material in its several hundred pages is so nicely gotten together that its careful pursual is suggested, as much of the detailed description of refractive technic will prove of real value to all practitioners.

The book is divided into chapters, each with a complete bibliography, this feature adding tremendously to its value as a reference text. The deft hands of the techincians of the scientific staff of the publisher as well as those of Dr. Charles Sheard are clearly discernible in this work and while naturally no direct credit is given these men by the publisher, the book again reflects their sterling worth.

C. C. K.

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THE COORDINATION OF REFRACTION WITH SPECTACLE AND EYE GLASS FITTING.

Sidney L. Olsho, M.D. Published by the Pelham Publishing Co., Philadelphia, Pa. 42 pages. 19 illustrations. 1928. $2.00.

Olsho suggests establishing what he terms the base line of a patient's face. This base line extends from one external canthus to the other, ignoring entirely any facial abnormalities. He suggests using a trial frame with a rigid front but with temples so made that they can be easily angled, this trial frame so placed before the patient that the horizontal meridian of the test lenses falls along the patient's base line. The same position is naturally to be followed in later making the optical appliances as prescribed. This work is well illustrated to bring out the various points the author wishes to emphasize and closes with two short chapters on vertex refraction. Optometrists should give more attention to this important phase of ocular refraction as outlined by Olsho.

T. O. B.

ANNOTATIONS AND SOCIETY PROCEEDINGS

The American Journal of Optometry is the official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

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PLAN TO AID THE YOUNG GRADUATE OPTOMETRIST

Four years ago at Columbia University, Dr. A. L. Graubart spoke before the Columbia University School of Optometry Association, on what he termed the "Cooperative Plan." This plan was devised in such a way so that the recent graduate would be able at once to open a professional office.

Dr. Graubart showed how by having a group of about ten optometrists using the same suite of rooms, the same reception room but with individual refracting rooms, sharing overhead expenses, would in time build up independent practises. But, while he is building up this practice, he should still keep his salaried position that he holds elsewhere to insure a steady income. The practice of these men should be run by appointment only and, as all the patients come recommended, there should, he claims, be no conflicts.

The idea was received with a great deal of enthusiasm; but, the big hindrance was the initial outlay—such as equipment, furnishing, etc., because the recent graduate usually cannot afford to buy a complete refracting room equipment. By a complete outfit, I mean a room that has at least the following, which every professional optometrist should possess: A large comfortable patient's chair, an ophthalmometer, reading lamp, refractor, visual test apparatus, large trial cabinet and trial lenses, ophthalmoscope, dynamic and static retinoscopes, perimeter, transilluminator, operator's stool, test frames,

kratometer and myoculator. With this equipment, a refractionist of ability can give the ocular service that the public deserves.

Time and time again, Dr. Graubart has tried to interest individuals in his plan. They all agreed that the idea was ideal for the new graduate, but they all complained of the initial expense. Finally, the proposition was taken to the New York Academy of Optometry, where he outlined his plan. The Academy was asked to adopt the following resolutions:

"Whereas the New York Academy of Optometry considers its first duty the encouragement of those desiring to practice optometry in an ethical and professional manner, and

"Whereas it is necessary for the New York Academy of Optometry to have research facilities including a library, laboratory and museum, and

"Whereas it is necessary to possess proper quarters for these facilities, and

"Whereas it is so often difficult for the beginner in optometry to establish himself in an ethical and a secure financial basis,

"Therefore be it resolved:

"That the New York Academy of Optometry adopt the 'Cooperative Plan' proposed by Dr. A. L. Graubart which provides for the maintenance of quarters and facilities above mentioned and so arranged as to permit a group of about ten optometrists to conduct private practices at relatively low overhead costs. A board of trustees elected by the Academy to provide the rooms, equipment, attendant and to maintain control. And, be it further resolved that the committee in charge of this matter be empowered to obtain competent legal advice."

The New York Academy of Optometry accepted the above resolutions on the condition that there is a big enough demand from those who wish to take part in the plan. If this plan proves successful, the New York Academy of Optometry expects to assist in the establishment of other cooperative plan offices. Dr. Graubart believes that this plan will be followed by others of similar nature all over the United States. Any optometrist wishing to take part in this plan should communicate with Dr. A. L. Graubart, Suite 3, 618 West 177th Street, New York City.

* * * *

TWENTY-SIXTH OHIO STATE CONVENTION

Dr. R. M. Hall announces the plans for the twenty-sixth annual convention of the Ohio State Optometric Association. This gathering will be held in Cleveland, September 2nd, 3rd, 4th and 5th, with headquarters at the Hotel Statler.

Dr. C. B. Ellis of the Ohio State University will speak on "Professional Ethics and Procedure of the Refracting Room," Dr. Morgan C. Davies, newly appointed head of the optometric section of

Ohio State University will speak on the "Pathological Aspect of Strabismus," and on "Fusional Development and Training." Dr. Charles Sheard of the Mayo Clinic, Rochester, Minnesota, will speak on "Accommodation and Convergence Relationship" and also on "Dynamic Skiametry."

Dr. Hall writes that emphasis is being placed by the committee on the need for modern equipment and such time is being allotted to the display of new refractive apparatus.

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UNIVERSITY OF ILLINOIS GRADUATE COURSE

A special course of lectures for practicing optometrists will be given at the University of Illinois on Thursday and Friday, September 13 and 14, respectively. The course consists of eight lectures on "The Optics of Vision." The following members of the faculty will lecture on topics to be announced soon: Professors A. P. Carman, W. F. Schultz and R. F. Patton, of the department of Physics; C. R. Griffith, director of psychological research in athletics, and W. E. Burge, of the physiology department. All lectures will be given at room 100, Physics Building on the university campus which is located near Urbana.

This course is being arranged for and given in connection with, the down-state meeting of the Illinois State Optometric Association. The registration fee to members is $5, and $20 to non-members.

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ANNUAL CONGRESS OF THE AMERICAN OPTOMETRIC ASSOCIATION

Dr. George Houghton of West Summerville, Massachusetts, was elected president of the A. O. A., at its recent meeting in Grand Rapids, Michigan. The other officers of the Association are: Dr. Arthur E. Hoare, Los Angeles, California, first vice-president; Dr. E. T. Myer, Pennsylvania, second vice-president; Dr. E. Kiekenapp, Faribault, Minnesota, secretary, and Dr. F. A. Stengel, Marion, Ohio, treasurer. Dr. Mayer of New York, Dr. Kimball of Missouri and Dr. Mollie Armstrong of Texas were elected to the executive board.

In collaboration with the Michigan Committee on Education comprised of Doctors DeGraff, Ohlsson and Arnold; Dr. H. R. Spitler of Eaton, Ohio, director of the A. O. A., arranged a three-day program of lectures, the talks being given as follows: "A Routine Refraction," by Dr. Carel C. Koch of Minneapolis, Minn.; "Muscular Anomalies" and "Optometric Interpretation of Ocular Pathologies," by Dr. W. B. Needles, of Chicago, Ill., and "Binocular Balance," by Dr. R. M. Peckham of Waterbury, Conn. These lectures were published in book form by the A. O. A. Copies can be secured from the Department of Education. In addition to these published lectures, Dr. Charles Sheard of the Mayo Clinic of Rochester, Minn., spoke on "Radiant Energy With Reference to the Eye" and also on "Optometric Differential Diagnosis." The first of these lectures

dealt with the effects of the short ultra-violet and the long infra-red rays on the tissues of the eye. The second with the proper interpretations of the findings of a routine refraction. Dr. F. A. Woll of the College of the City of New York spoke at some length on "Ocular Hygiene" and also on the "Physiology of the Muscles of the Eye."

The success of the convention and its educational congress was in a large measure due to the splendid efforts of the Michigan Optometric Association. The 1927 Congress will be held at Philadelphia.

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OKLAHOMA ASSOCIATION ACTIVITIES

The board of directors of the Oklahoma Association of Optometrists appointed the following committees for the current year: Legislative Committee—Dr. George T. McVey, Oklahoma City, chairman; Drs. F. M. Sheets, Blackwell, J. B. Smith, Alva; N. O. Barnhill, Oklahoma City, and J. W. Bishop, Claremore; Educational Committee—Dr. W. S. Farmer, Oklahoma City, chairman; Drs. C. I. Hannis, Tulsa, C. H. Dillingham, Frederick, C. H. Beavers, Enid, A. R. Zellers, Kingfisher, W. A. Grady, Stillwater, and R. R. Fretwell, Drumright. Publicity Committee—Dr. H. S. Hannis, Tulsa, was made chairman. Law Enforcement Committee—Dr. V. E. Bowers, Lawton, was reappointed chairman of that committee.

A special effort is being made jointly by the State Association and State Board to prosecute vigorously, all law violators. All complaints and charges relative to unprofessional and unethical conduct on the part of optometrists, should be sent to Dr. V. E. Bowers, at Lawton, and complaints relative to optometry law violators, such as persons practicing without a license or the use of self-testing machines should be sent to Dr. E. B. Alexander, at Duncan, secretary of the State Board.

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CONNECTICUT ASSOCIATION MEETING

The third quarterly meeting of the Connecticut State Association was held on July 10th at the Elton Hotel at Waterbury. Dr. H. E. Jones of Hartford, president of the Association, was elected as delegate to the A. O. A. convention. Dr. Oscar McCulloch of Holyoke, Massachusetts, spoke on "Muscular Imbalances."

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UNIVERSITY OF SOUTHERN CALIFORNIA

Dr. Ernest A. Hutchinson, vice-president of the Los Angeles School of Optometry announces that his organization will affiliate with the University of Southern California, this change to take place on September the first of this year. The optometry course will now be given on the campus of the university as an integral part of that educational institution.

INDIANA OPTOMETRISTS ORGANIZE

Dr. Mary L. Clay of Ft. Wayne, Indiana, announces the organization of optometrists of northeastern Indiana for educational purposes. Dr. Ralph Blume was elected president, Dr. Clay secretary, and Dr. J. C. Fager, treasurer. This organization will meet on the the third Monday of each month.

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SCEFFINGTON SPEAKS IN NEBRASKA

A successful week of graduate work has just been completed in Nebraska according to Dr. L. G. Miller of Lincoln who as secretary of the Nebraska Optometrists Club sponsored the week's clinic conducted by Dr. A. M. Sceffington. Sixteen Nebraska optometrists were in attendance.

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OKLAHOMA STATE BOARD

A meeting of the Oklahoma State Board of Optometry was held in Oklahoma City, July 2nd and 3rd. At this time, due to the appointment of Dr. E. B. Alexander of Duncan, the board was reorganized. Dr. E. E. Russell of Altus was elected president and Dr. E. B. Alexander was elected secretary and treasurer. Dr. R. C. Everts of Weatherford is the third member of the board. License fee renewals for Oklahoma practitioners should now be sent to Dr. Alexander.

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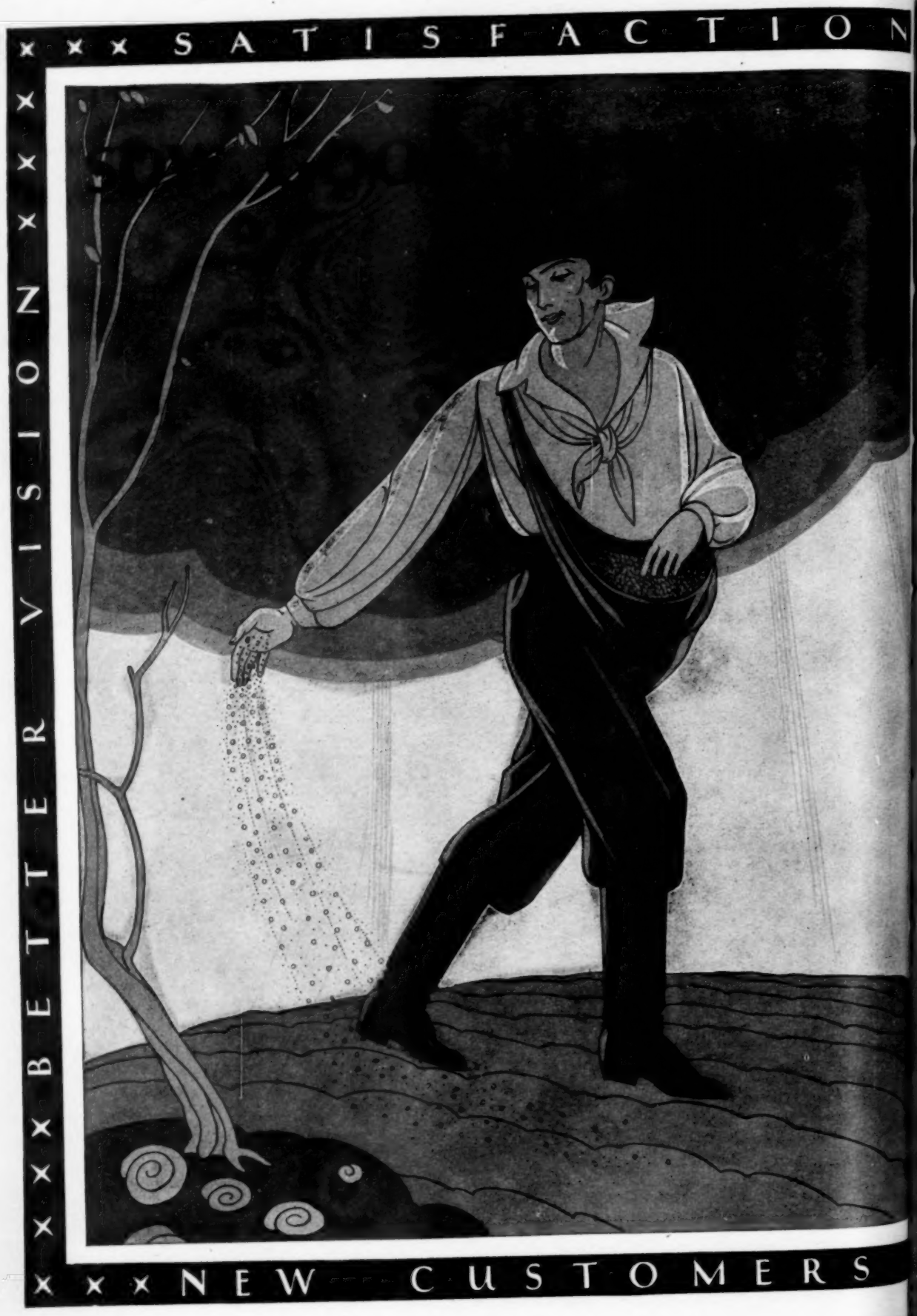
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